Development of a Radiation Climate Data Record Combining ERBE and AVHRR

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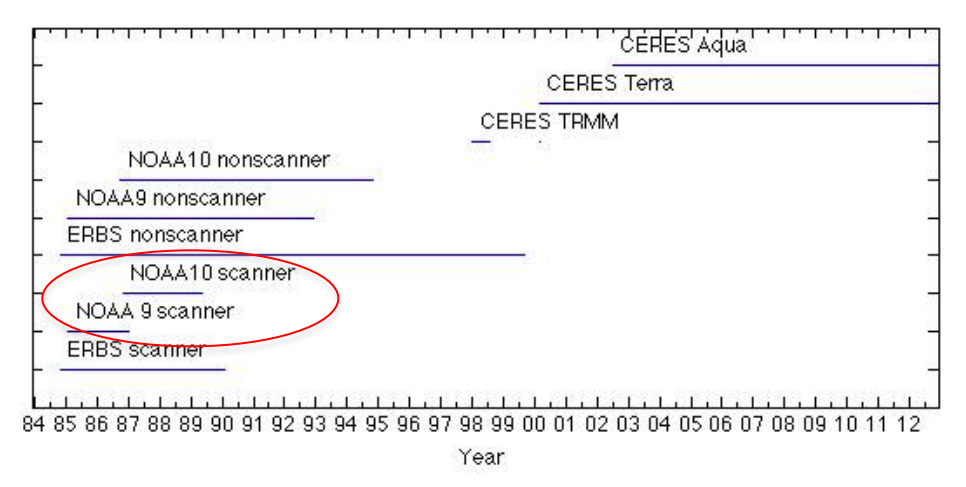
Outline

- Project Description
- Production and QA Approach
- Applications
- Schedule & Issues

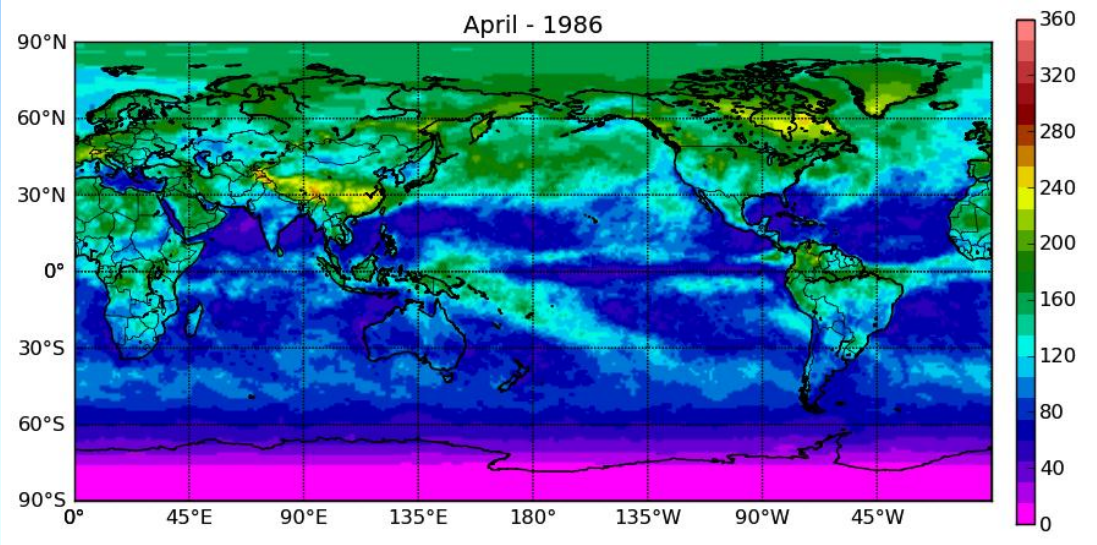
CERES-like ERBE Project Description

- To provide TOA and surface radiative fluxes derived from ERBE observations from February 1985 to January 1987 (NOAA 9) and from January 1987 to May 1989 (NOAA 10) for climate studies..
- Use consistent algorithms with the CERES process (e.g. scene ID given by AVHRR to use CERES angular distribution models, surface radiative fluxes, and better temporal and spatial interpolations).

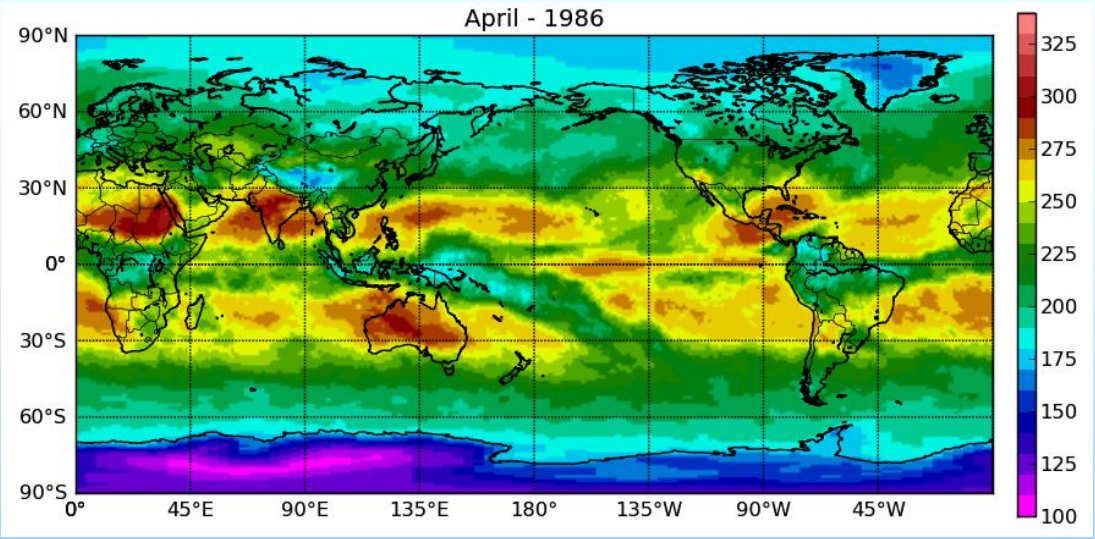


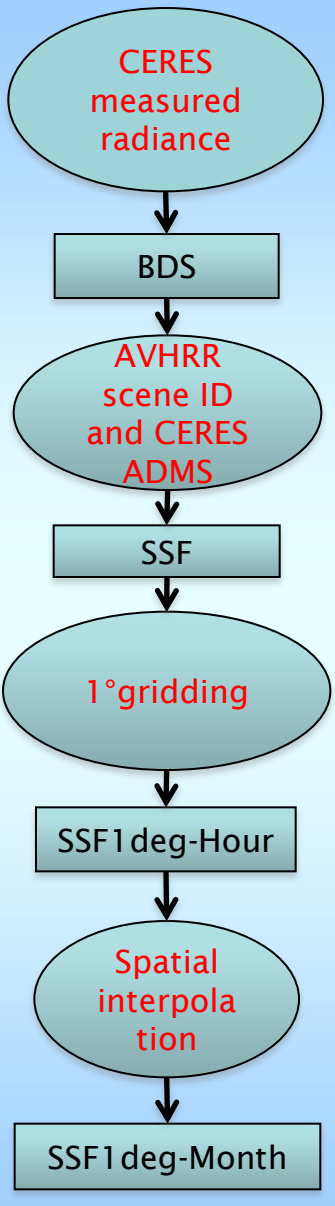
Monthly mean 1° ×1° TOA irradiance

TOA shortwave



TOA Longwave

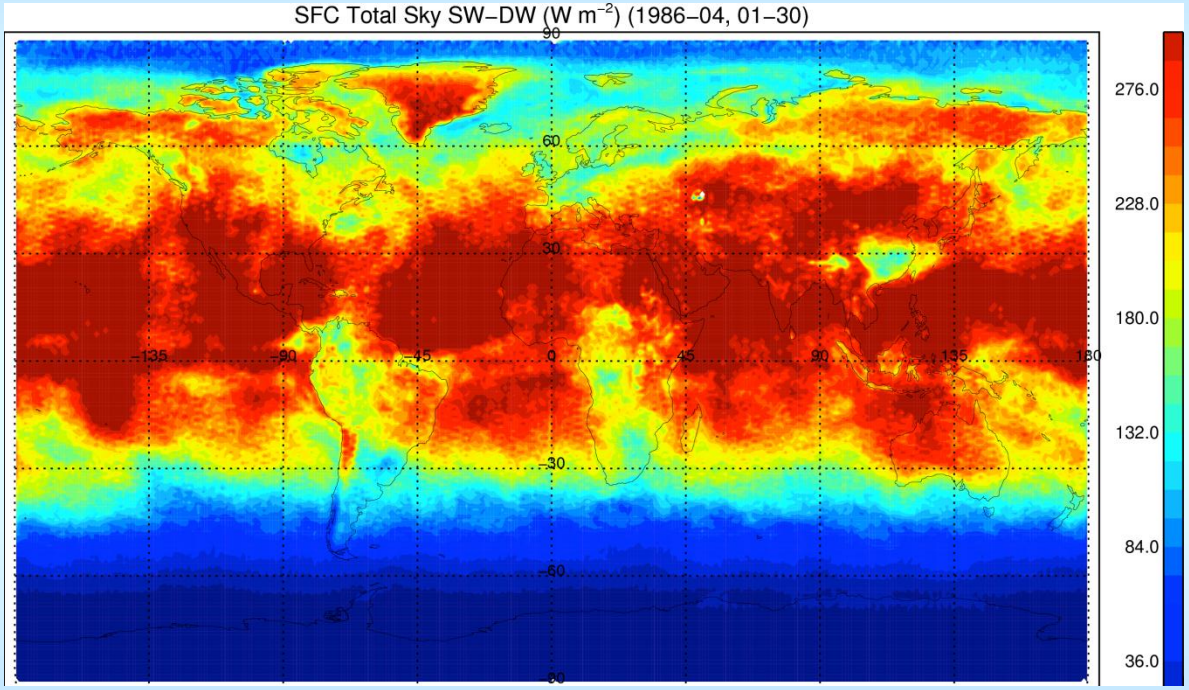


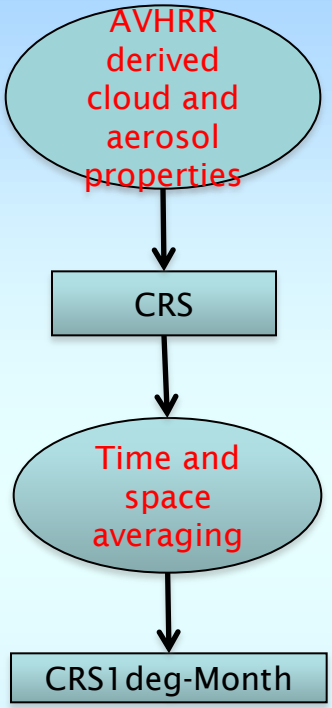


Level 3, gridded monthly mean TOA shortwave and longwave irradiances

Monthly mean 1° ×1° Surface irradiance

Downward shortwave (diurnal cycle is not taken into account yet)





Level 3, gridded monthly mean TOA shortwave and longwave irradiances

CERES-like ERBE data products

- CERES algorithm provides a better spatial resolution (1° ×1° versus 2.5° × 2.5°).
- Irradiances can be analyzed as a function of cloud type.
- Irradiance change between ERBE and CERES periods can be analyzed.
- Provides surface irradiances (shortwave and longwave).

Project Description

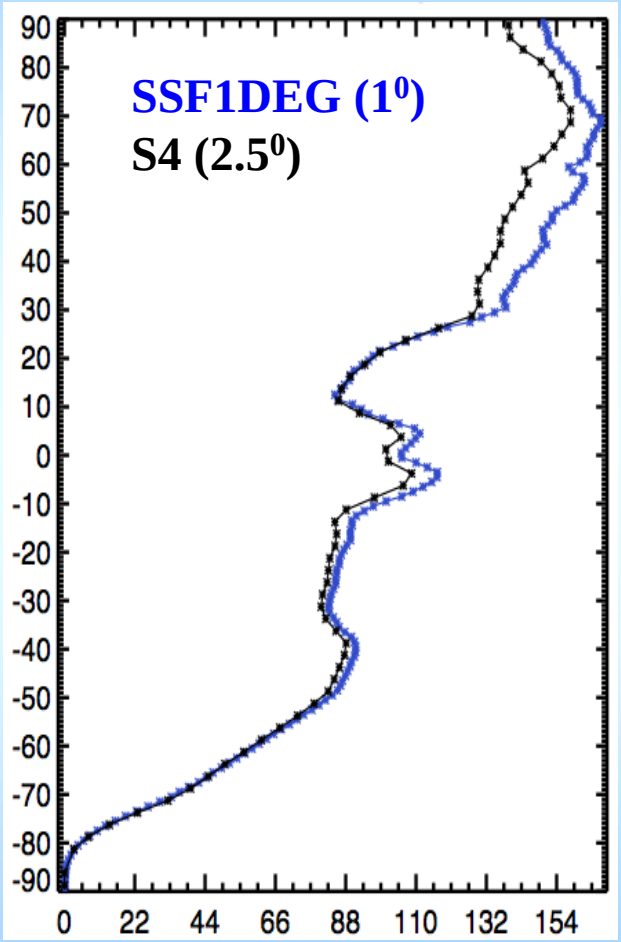
CDR(s) (Validated Outputs)	Period of Record	Spatial Resolution; Projection information	Time Step	Data format	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial and/or unvalidated)
TOA reflected shortwave irradiance outgoing longwave irradiance **Surface** Upward shortwave irradiance Downward shortwave irradiance Upward longwave irradiance Downward longwave irradiance	February 1985 – January 1987 (NOAA 9) November 1986 – May 1989 (NOAA 10)	Level 2: 30 km ERBE footprint Level3: 1°×1°	Level2: Instantaneous Level3: Monthly	NetCDF	**TOA** ERBE SW, LW radiance AVHRR-derived cloud properties Daily snow map **Surface** Albedo emissivity map GMAO-reanalysis (MERRA) Aerosol model (MATCH)	**TOA** Monthly 20°×20° regional Shortwave 1.3Wm^{-2} (out of 342Wm^{-2}) Longwave 0.8 Wm^{-2} (Effect of cloud retrieval errors is excluded) **Surface**[1] Monthly regional Shortwave up 11Wm^{-2} (out of 23 Wm^{-2}), Shortwave down 10Wm^{-2}(out of 192 Wm^{-2}) Longwave up 15Wm^{-2}, longwave	

TOA and surface irradiance Level 3 Production Approach

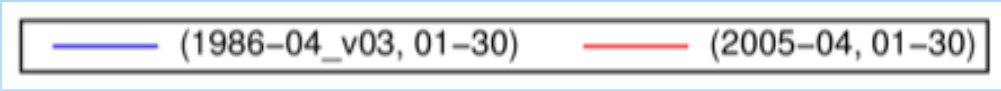
- ERBE observed radiances are converted to irradiances using CERES Aqua Angular Distribution Models (ADMs, Loeb et al. 2005)
- Scene ID (cloud fraction, cloud optical thickness, cloud top and surface temperature etc.) is given by AVHRR (CDR project, PI: P. Minnis)
- Averaging irradiances for 1° ×1° and every hour box by temporally interpolating sampling from an sun-synchronous orbit
- Surface irradiances are computed using AVHRR derived cloud properties, GMAO reanalysis (MERRA), and aerosols from AVHRR (Mishchenko et al. 1999) and a transport model (MATCH, Collins et al. 2001).

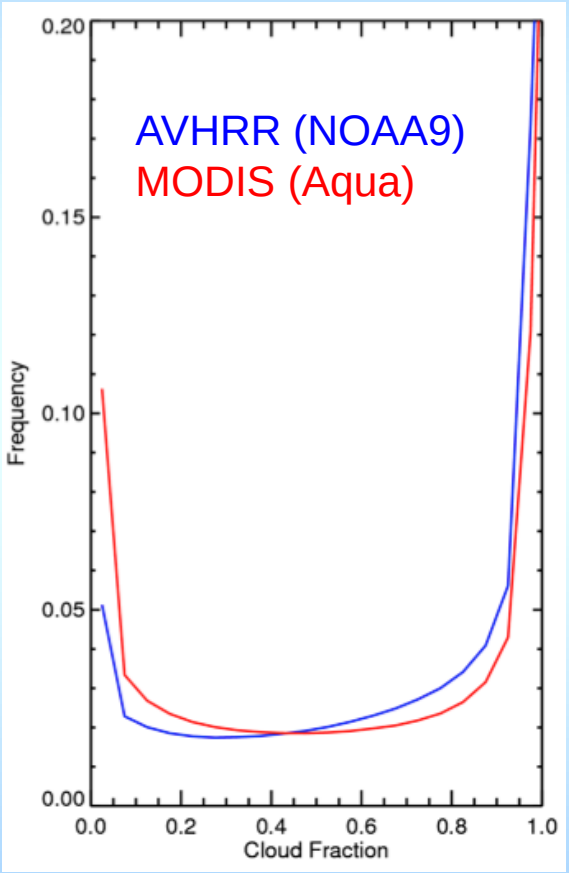
Challenges: instrument vs. real change

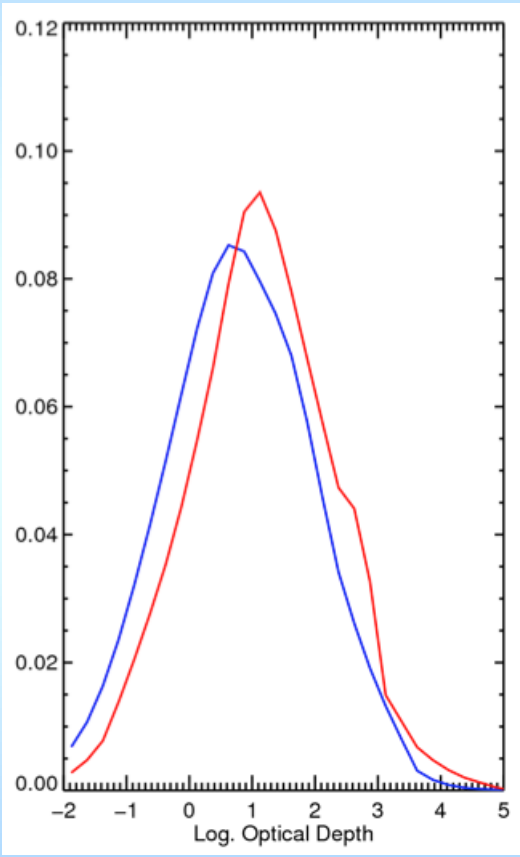
Shortwave All-Sky TOA Flux
Zonal Mean



Clouds over ocean (Monthly, Global)



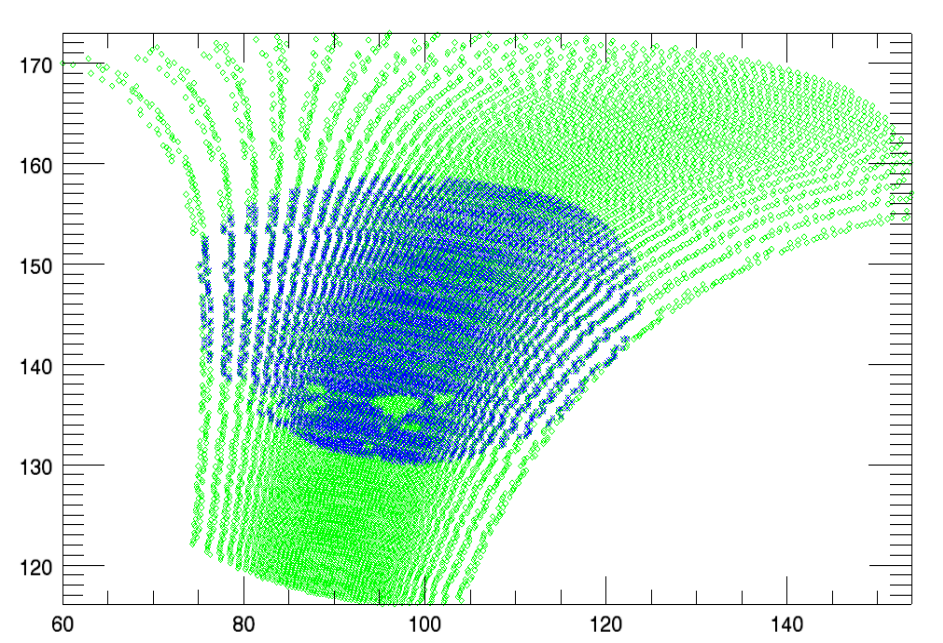


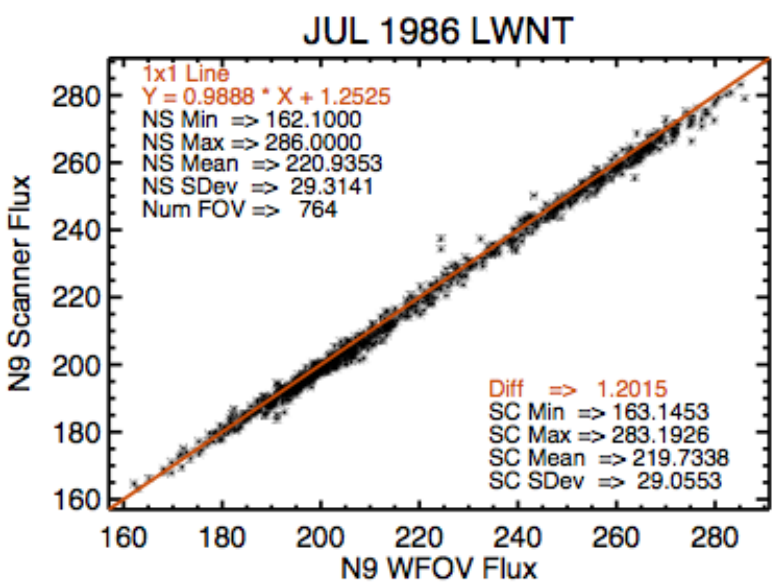


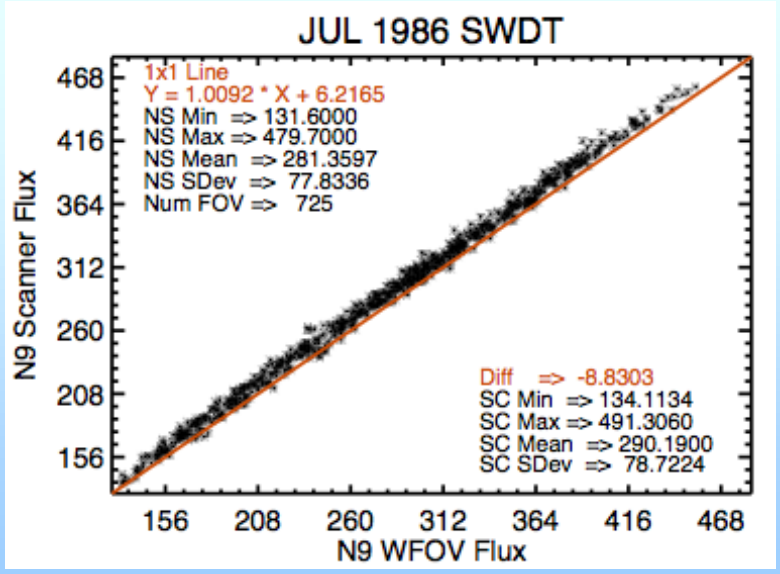
Distribution of cloud fraction and optical thickness differ from those derived from MODIS due to the imager's resolution difference (1 km versus 4 km) and CERES footprint size versus ERBE footprint size (20 km versus 45 km)

Calibration uncertainty

Collocate scanner radiances with non-scanner Footprints



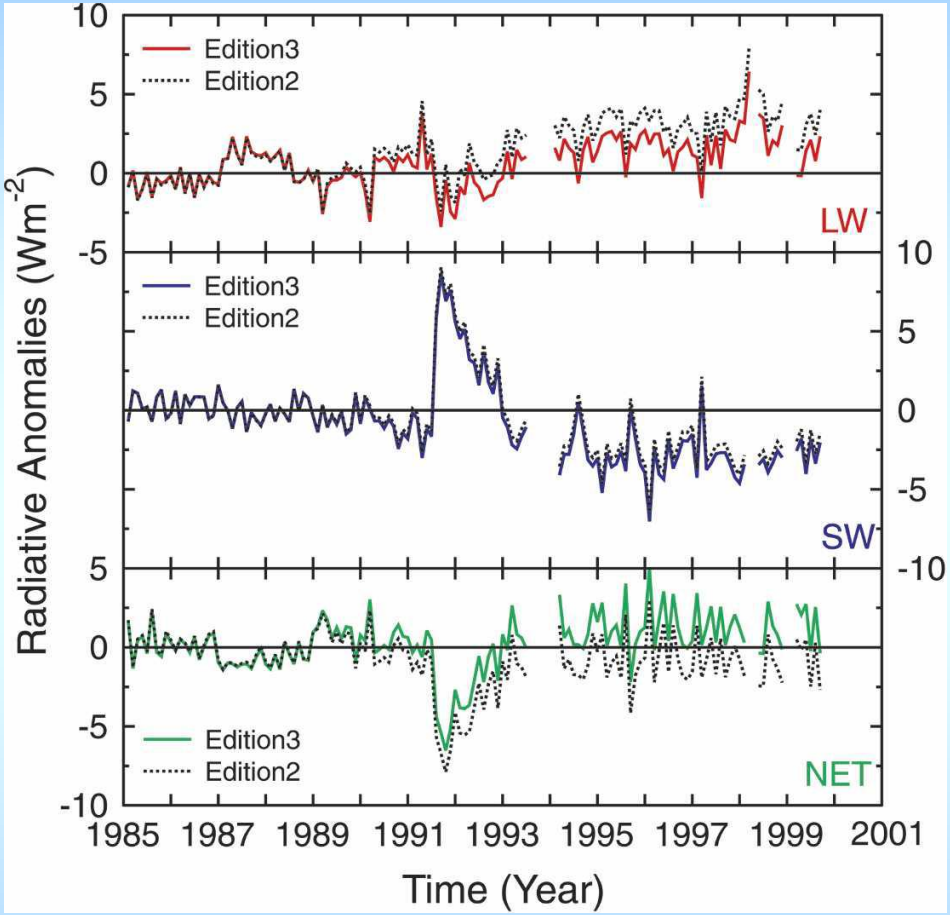




TOA irradiances are compared and will be Calibrated against ERBS, NOAA9, and NOAA10 non-scanners

Quality Assurance Approach

Tropical radiation anomalies



Tropical mean decadal change
Between 1980s to 1990s
(Wong et al. 2006)

LW 0.7 Wm^{-2}
SW -2.1 Wm^{-2}
Net 1.4 Wm^{-2}

CERES TOA flux uncertainty 1σ
SW 1%
LW 0.8%

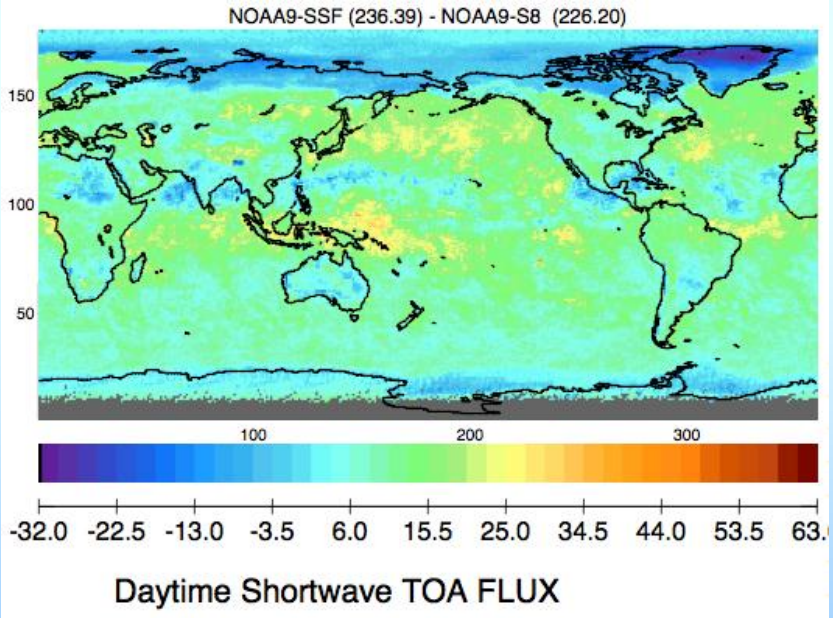
ERBE TOA flux uncertainty 1σ
SW 2%
LW 1.5%

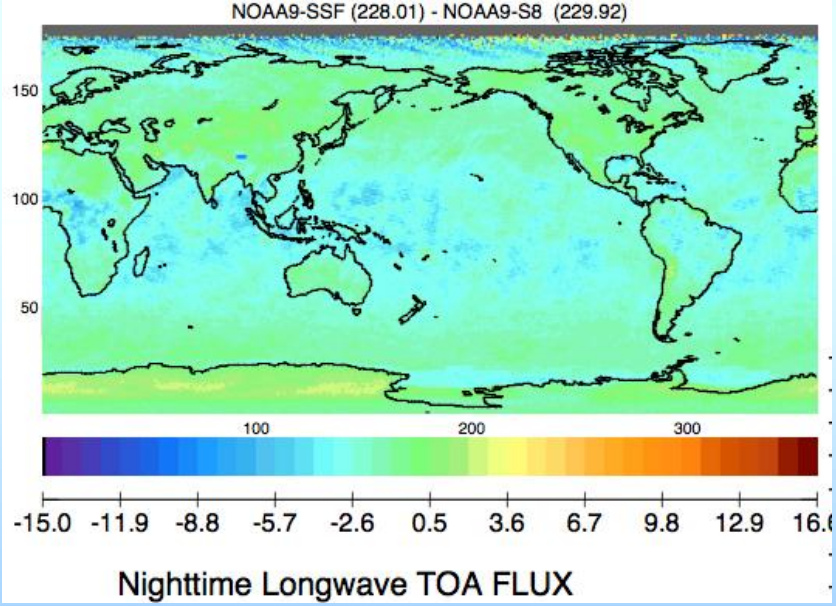
Wong et al. 2006 J Climate

Tropical and global mean radiative
flux change will be investigated from
Both actual change and instrument calibration
Uncertainty (e.g. SW 8 Wm^{-2} difference is ~2σ)

Quality Assurance Approach

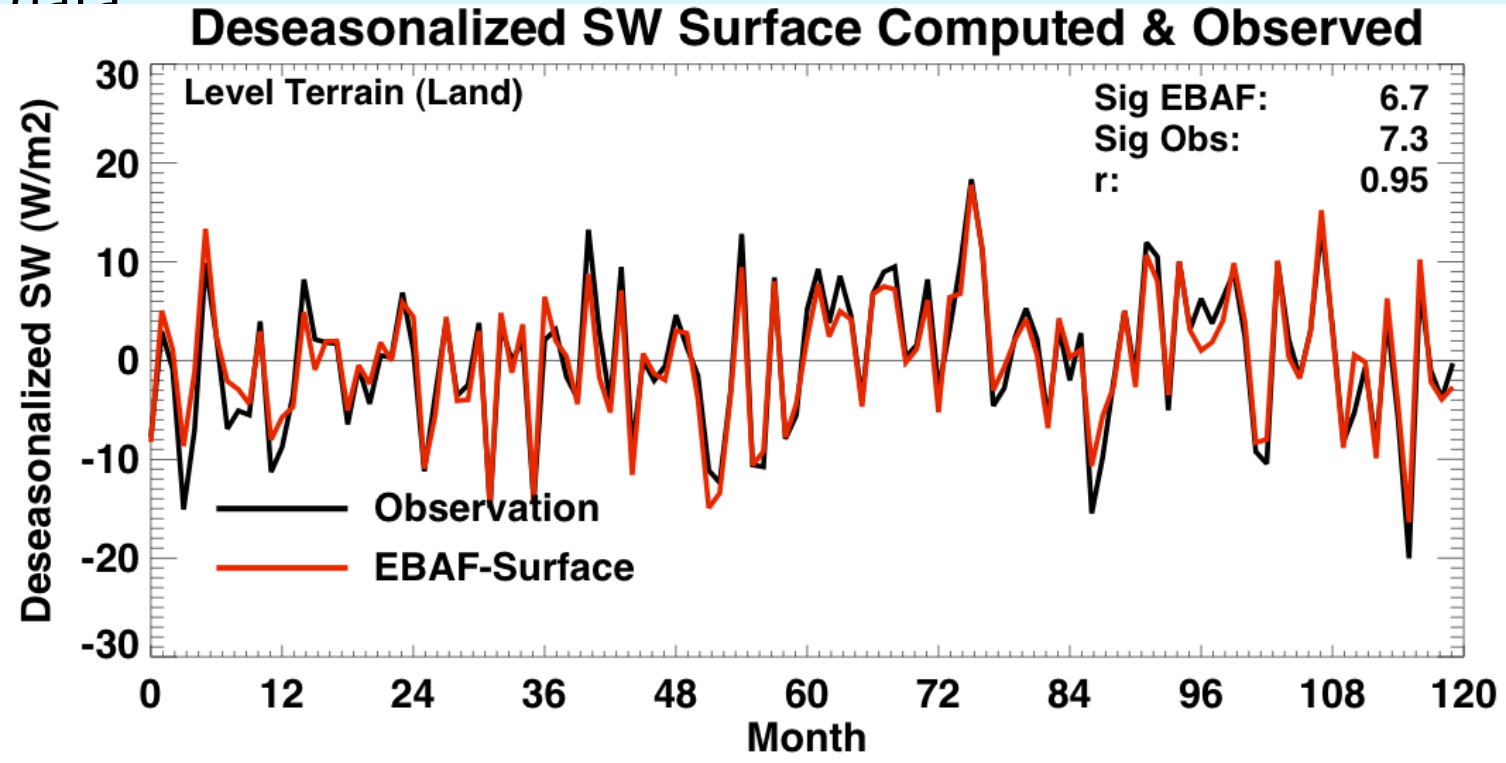
1. Comparison with original ERBE data (shown below)
2. Comparison with Aqua CERES data
3. Viewing angle dependence of radiative flux
4. Scene type dependence of unfiltered radiances
5. Comparison with computed radiative flux





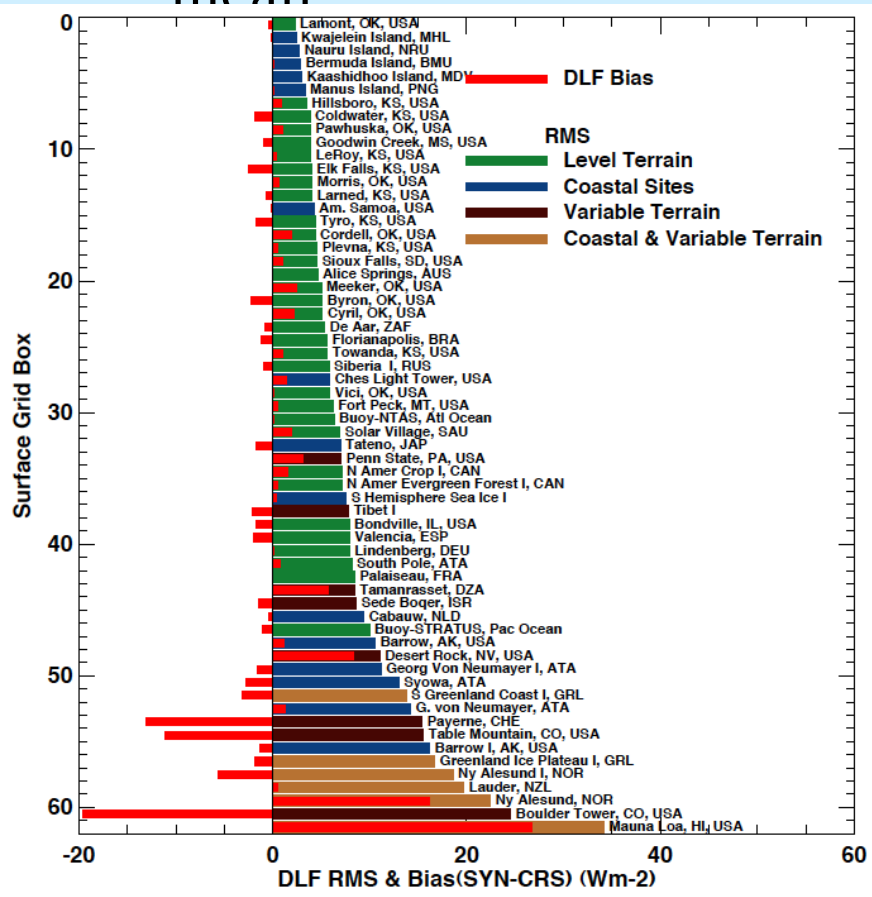
Application of surface irradiance

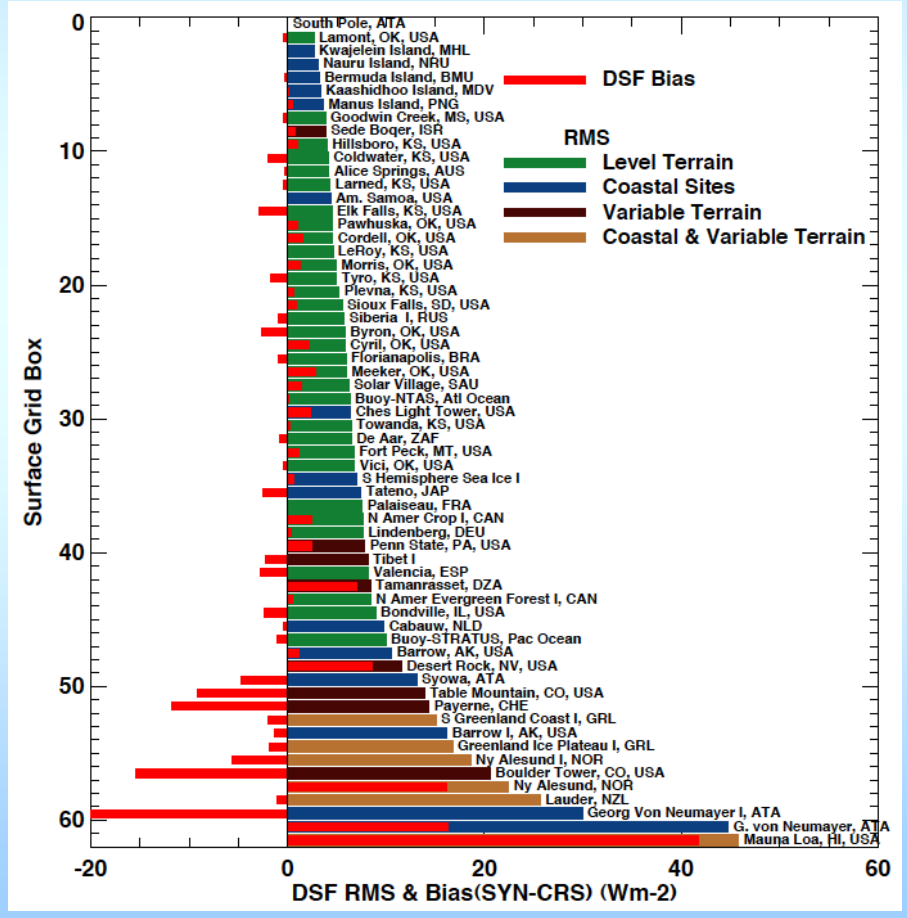
- Solar forecasting (Energy, Agriculture)
  - Surface irradiance data can be used to understand variability of solar (shortwave) irradiance at the surface. Variability at any grid boxes can be assessed using our data



Application of surface irradiance

- Solar forecasting
  - Variance/bias of downward shortwave and longwave observed at one site within a grid box versus the grid mean





Schedule & Issues

- Project status
  - Beta version of 2 years of NOAA 9 ERBE Level 2 (SSF) and 3 (SSF1deg-Month) is almost complete (TOA irradiance).
  - Beta version of level 2 CRS is almost complete (surface irradiances).
  - Algorithm to collocate scanner radiances with non-scanner footprints is developed.
  - Third year: time and spatial sampling algorithm (level 3 TOA and surface fluxes), NOAA 9, NOAA 10 ERBE scanner calibrations, NOAA 10 process

- Risks and concerns
  - Need to assess the impact of imager resolution (AVHRR 4 km versus MODIS 1 km).
  - Mitigate the impact of imager resolution difference might be difficult (significant research might be involved).
  - Geostationary satellite calibrations
- How can the CDR Program better assist you?
  - Suggestion of applications, especially for agriculture and industries